Crowne Plaza Renovation

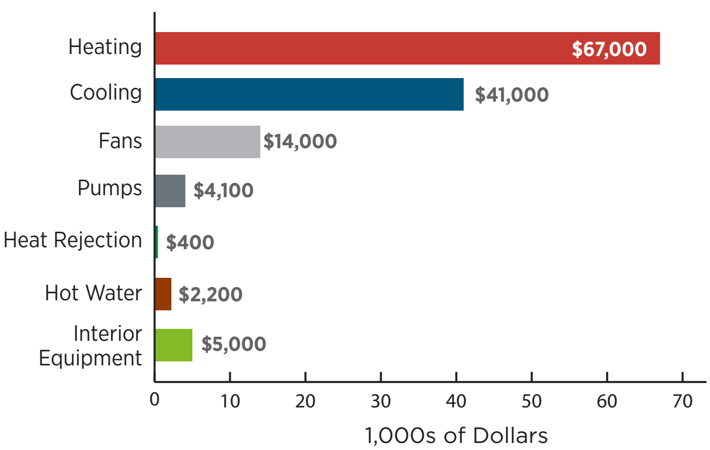
InterContinental Hotels Group (IHG) and its franchise partner B.F. Saul Company Hospitality Group (B.F. Saul Co.) partnered with the Department of Energy (DOE) to develop and implement solutions to retrofit existing buildings to reduce historic building use or the energy consumption by at least 30% versus requirements set by Standard 90.1-2004 of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), the American National Standards Institute (ANSI), and the Illuminating Engineering Society of North America (IESNA) as part of DOE's Commercial Building Partnerships (CBP) Program.[1] Pacific Northwest National Laboratory provided technical expertise in support of this DOE program.

As one of the world's largest hotel groups and a leader in the hotel industry, IHG has a record of environmental achievement that includes the first hotel ever to be powered 100% by renewable sources and being the first major hotel group to measure its water and energy consumption worldwide. IHG was the first company awarded a Leadership in Energy and Environmental Design endorsement for an existing hotel program—Green Engage.

Crowne Plaza worked with the U.S. Department of Energy's Commercial Building Partnerships Program to identify energy saving measures that could reduce energy consumption by 29%. An estimated 10% savings have been implemented to date.

Project Type	Lodging, Retrofit
Climate Zone	ASHRAE Zone 4A, Mixed-Humid
Ownership	Owner Occupied
Barriers Addressed	Need to strive toward final goal as incremental retrofit projects are implemented
Square Footage of Project	144,000
Expected Energy Savings versus Historic Operations	29%, 10% implemented to date
Expected Energy Savings (versus ASHRAE 90.1-2004)	24%
Expected Energy Savings (to be verified)	1,714,000 kilowatt-hour (kWh) of electricity and 4,000 therms of natural gas/year
Expected Cost Reductions (versus Historic Operations)	$134,000/year[2]
Project Simple Payback	Less than 5 years
Estimated Avoided Carbon Dioxide Emissions	Approximately 12 metric tons/year[3]
Construction Completion Date	May 2013 (ongoing)

Expected Energy Cost Reductions



[1] The Commercial Building Partnerships (CBP) Program is a public/private, cost-shared initiative that demonstrates cost-effective, replicable ways to achieve dramatic energy savings in commercial buildings. Through the program, companies and organizations, selected through a competitive process, team with U.S. Department of Energy (DOE) and national laboratory staff who provide technical expertise to explore energy-saving ideas and strategies that are applied to specific building project(s) and that can be replicated across the market.

[2] Based on utility rates of $0.0761/kWh and $0.906/therm; source: EIA, February 2011, Commercial Buildings, Virginia

[3] Greenhouse Gas Equivalencies Calculator: http://www.epa.gov/cleanenergy/energy-resources/calculator.html.

Located near Reagan National Airport in Washington, D.C., the Crowne Plaza is a 14-story, full-service hotel with a restaurant, coffee shop, onsite laundry, offices, and conference rooms, making it a diverse and complex project. The building has more than 300 guest rooms and 144,000 square feet of conditioned space. Built in 1968, the building underwent a mostly cosmetic renovation in 1999. There have been no major energy efficiency updates to the building since it opened, and the CBP building energy audit was the first ever performed at the building.

Before the PNNL team could identify energy savings at Crowne Plaza, the team first needed to understand how the building used energy. To capture actual energy use patterns at the building, the team launched an intensive metering study. Metering a hotel is complicated because of the diverse types of energy use, irregular occupancy, and guests with varying schedules and habits. Detailed, metered end-use data for hotels are not available from any currently accessible public source.

The team extensively metered circuits and equipment, installing a total of 550 measurement devices in 32 guest rooms and on the electrical circuits for common areas of the hotel—lighting; elevators; heating, ventilation, and air conditioning (HVAC) components; and other equipment. Energy usage was monitored for 1 year; meters collected data at 1- or 5-minute intervals and the team downloaded the data monthly for analysis. The metered data revealed energy-use consumption patterns, variability of guest room energy use, daily load curves, monthly variations, and other aspects.

"I learned a lot about my building," said Tom Domeika, Regional Chief Engineer at B.F. Saul Co. "It would have taken me years to teach myself what I learned when the Partnership came in and started asking questions. This benefited me greatly, since now I know the building better and I can figure out what needs to be done much faster."

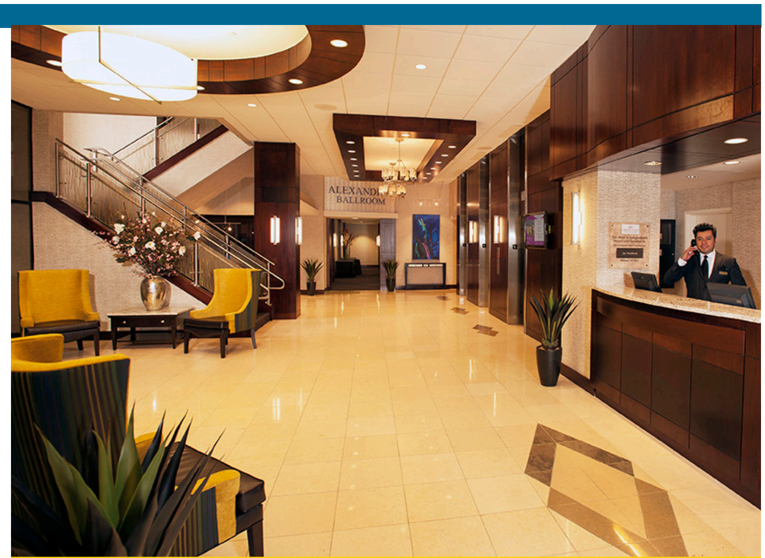
The significant effort of end-use metering contributed to a well-calibrated model which was used to develop and analyze energy efficiency measures (EEMs).

Decision Criteria

Crowne Plaza carefully evaluates the business case for energy improvements. Major factors that affect the hospitality industry include seasonal changes, business and leisure use, occupancy fluctuations, and corporate account sustainability policies. However, the most important criterion for making any hotel improvement is the potential impact on the guest experience.

Economic

B.F. Saul Co.'s traditional financial criterion has been return on investment for capital-related projects, but it is now giving more consideration to internal rate of return (IRR). Brand licenses have a 10-year life, so from the branding perspective, measures must have a return of less than 10 years. In general, franchise hotel owners consider a 3- to 5-year return acceptable.



Fixtures using light-emitting diodes (LEDs) are becoming cost effective for interior use because of their excellent color and long life. When the lobby was renovated to meet branding requirements, LEDs were installed with a small number of high efficiency halogen accent lights.

B.F. Saul Co. views the Crowne Plaza as a long-term investment. Consequently, it looked at the long-range effect of its decisions. Not only did it consider the effect a decision would have on its customers, but also the effect on future improvements and items such as equipment costs, equipment life, operational costs, and interaction with other building systems.

Branding

Franchise-based business models are common in the lodging industry, and as a franchisor, a company such as IHG holds the trademarks and establishes criteria for its brands. The franchisee enters into a long-term contract to represent the brand. These business relationships are complex and both sides need to weigh the interests and perspectives of the other when establishing branding standards and criteria, including standards for energy efficiency. The EEMs identified and lessons learned from this project have a much broader influence—reaching across IHG hotel brands and to its franchise partners.

Operational

After seeing the opportunities and effects of an integrated design with complementary EEMs, B.F. Saul Co. changed its view of what could be achieved at this hotel. The company evaluated the final package of recommended EEMs and determined the best path forward was to incorporate the EEMs into the major renovation plans instead of just undergoing equipment retrofits.

A well designed, major renovation offers many opportunities, such as improving space usage and comfort, enhancing operations, and reducing energy costs. The challenge is that a major renovation requires significant time and capital.

In the short term, B.F. Saul Co. now considers and implements CBP energy saving recommendations as part of regular maintenance and replacement work. When equipment is replaced (end of life, failure, high repair costs), instead of simply replacing with similar models, the level of energy use (energy efficiency) and how well the proposed component, equipment, or system provides the features needed for future plans are examined. The company looks ahead to determine what its needs will be to most effectively control its systems and sustain operational performance.

Policy

IHG had a company-wide benchmarking initiative that aimed to realize energy savings ranging from 6% to 10% in owned and managed properties by the end of 2012. IHG is participating in the Better Buildings Challenge by committing 24 million square feet of hotel space.

B.F. Saul Co. is strongly committed to environmental responsibility, piloting a program offering 100% renewable energy hotels to its guests. The company's "Our Big Green" initiative pledges to "Conserve, Recycle, and Act Now!" Crowne Plaza is committed to implementing these principles and has taken the following actions:

- Installed low-flow products to reduce wasted water for faucets, toilets, urinals, and shower heads
- Placed recycle receptacles in guest rooms and public places
- Introduced guests to a linen and towel re-use program
- Offered meeting attendees biodegradable writing pens and pitchers of filtered water instead of bottled water
- Instituted a "shut down" policy during times of low occupancy, closing certain floors or wings to conserve heat and cooling
- Significantly reduced administrative printing

In addition to engaging Crowne Plaza staff to actively participate in the program, the "Our Big Green" mascot goes to local schools and organizations to promote environmental awareness to the public.

B.F. Saul Co. also participates in IHG's Green Engage program for franchise and co-owned hotels. Green Engage is a point-based system that encourages improved performance and provides solution recommendations for sustainability challenges. Site data are input into Green Engage by each hotel, and a report and energy benchmark is generated that allows hotels to compare themselves. Green Engage also provides owners with advice on everything from picking a site to selecting the correct lighting. Return on investment, carbon reduction, and potential guest impact information are provided for each suggestion.

Energy Efficiency Measures

The Crowne Plaza used approximately 147 kilo British thermal units (kBtu)/square foot (ft^2) of energy per year—almost 50% more energy than a typical hotel in the United States based on the Commercial Building Energy Consumption Survey of 2003.[1] This energy use is not surprising given the hotel's age and lack of upgrades.

Heating consumed the most energy at Crowne Plaza, especially the packaged terminal heat pumps (PTHPs) used to heat the guest rooms. Plug loads—which represent all equipment plugged into an electrical outlet—were the second largest energy consumer and cooling was the third. Water heating also used a significant amount of energy.

The final package of recommended EEMs reduced the loads and energy usage by modifying the building envelope, reducing HVAC and plug loads, and then meeting these reduced loads with more efficient HVAC strategies.

Total electricity savings from all the EEMs based on the EnergyPlus model and other calculations was estimated at nearly 2 million kWh, a 32% reduction in electricity consumption in comparison to historic operations and a small increase in natural gas use of about 3%. The baseline end-use intensity (EUI) was estimated to be reduced from 147 kBtu/ft^2 to 104 kBtu/ft^2, a reduction in total building energy consumption of approximately 29%. The estimated cost reductions from various efficiency measures are shown in the following table. These savings do not include potential reduced maintenance costs. The annual reduced energy cost for the EEM package amounts to approximately $134,000. The HVAC measures reduce the most energy and costs.

Two EEMs are important to note for hotels because of their reasonable paybacks and widespread applicability. One is the upgraded packaged terminal heat pump units. Incremental costs are low in comparison to less efficient units, but change outs are only likely to occur at the end of the useful life of existing equipment or during renovations or new construction. The second is the laundry ozone system for facilities with in-house laundries. These retrofits can be happen at any time.

> "This program is helping us make decisions about our building systems. This is not like changing a light bulb; we are engaging our larger systems. It makes a big difference."
>
> — Jim Walent, Vice President,
> B.F. Saul Company Hospitality Group

[1] CBECS 2003.

Energy Efficiency Measures

Building energy improvements at the Crowne Plaza hotel included the building envelope, interior and exterior lighting, and the HVAC systems. Reduced energy costs from these measures are presented in the following table. The EEMs are presented ranked by expected annual savings. Percentages listed for each category represent measures that have been implemented to date. Savings from measures installed to date amount to 10% of historic operations

EEM	Implementing in This Project	Will Consider for Future Projects	Expected Annual Saving		Expected Improvement Cost[1]	Expected Cost of Conserved Energy $/kWh[2]	Expected Simple Payback yr
			kWh/yr	$/yr			
Envelope: 0% of Whole Building Savings *(implemented to date)*							
Replace windows* U-value summer 0.26 U-value winter 0.28 Solar heat gain coefficient of 0.27 with Low-e	Maybe[3]	Yes	252,000	$28,000	$900,000	$0.86	>20
Add exterior wall insulation to R-13*	Maybe[3]	Yes	116,00		$600,000		>20
Lighting: 1% of Whole Building Savings *(implemented to date)*							
Renovate lobby - redesign of lighting and use of light-emitting diodes and highest efficiency halogen accent lights	Yes	Yes	39,000	$3,000	$60,000	$0.33	20
Replace T-12 fixtures, ballasts and lamps with T-8 lamps and ballasts that meet the Consortium for Energy Efficiency/National Electrical Manufacturers Association High Performance T-8 Specification	Yes	Yes	17,000	$1,000	$21,000	$0.26	16
Use occupancy sensor controls in restrooms, offices and other spaces not always occupied	Maybe	Yes	5,000	$400	$2,000	$0.06	4
Replace elevator fixtures with light-emitting diode fixtures	Yes	Yes	2,000	$100	$1,000	$0.08	5
HVAC: 10% of Whole Building Savings *(implemented to date)*							
Upgrade to premium efficiency packaged terminal heat pump units (energy efficiency ratio of 12)*	Yes	Yes	723,000	$72,000	$30,000[4]	$0.04	2
Adjust guest room occupancy-based thermostat reset (4°F)	No	Yes	222,000		$140,000		
Upgrade air handling units from constant air to variable air volume	Maybe[3]	Yes	403,000	$31,000	$425,000	$0.22	14

EEM	Implementing in This Project	Will Consider for Future Projects	Expected Annual Saving		Expected Improvement Cost[1]	Expected Cost of Conserved Energy $/kWh[2]	Expected Simple Payback yr
			kWh/yr	$/yr			
HVAC *(continued from previous page)*							
Add public space occupancy-based thermostat reset (4°F)	Maybe[3]	Yes	154,000	$12,000	$10,000[5]	$0.01	<1
Convert chilled water system from constant flow to variable flow	Yes	Yes	70,000	$5,400	$10,000	$0.03	2
Enable economizer operation*	Maybe[3]	Yes	18,000	$1,400	$5,500[5]	$0.06	4
Service Hot Water: <2% of Whole Building Savings *(implemented to date)*							
Install laundry ozone system	Yes	Yes	3,700 therms -2,400 kWh	$3,200	$15,000	$0.08	5
Install low-flow showerheads (2 gal/min or less)	Maybe	Yes	2,400 therms	$2,200	$30,000	$0.22	14
Miscellaneous Electrical Loads: <1% of Whole Building Savings *(implemented to date)*							
Implement demand control ventilation for the kitchen	Maybe[3]	Yes	70,000	$5,300	$9,000	$0.03	2
Reduce kitchen exhaust cubic feet per minute	Maybe[3]	Yes	38,000	$3,000	$7,000	$0.04	2
Replace kitchen cooking equipment and implement off-hours shut down	Maybe[3]	Yes	1,500 therms 16,000 kWh	$2,500	$53,000	$0.33	>20
Replace ice machines with ENERGY STAR-rated machines	Maybe	Yes	2,200	$200	$43,000	$4.11	>20
Install *VendingMiser* program on vending machine	Maybe	Yes	26,000	$2,000	$3,000	$0.02	1
Implement kitchen off-hours air handling unit shutdown	Yes	Yes	22,000	$1,700	Behavioral/ Training		

* EEM is dependent on climate.

[1] Improvement costs have been estimated by the design team and may not reflect actual costs observed by Crowne Plaza.

[2] Meier 1984.

[3] This measure would be included in a potential renovation.

[4] This cost is an incremental cost.

[5] Cost estimate is based on implementation of air handling units variable air volume upgrade measure.

Energy Use Intensities By End Use

To establish a baseline that reflected the building's current energy use, the team developed a building energy model using DOE's simulation program EnergyPlus—a powerful and versatile tool that uses data on heating, cooling, ventilation, lighting and other energy use systems to predict how EEMs will perform.

A building energy model is only as accurate as the data input it receives. For Crowne Plaza, the team relied heavily on data from the metering study—it closely coordinated the metered data analysis with the building energy modeling to provide daily profiles of the guest room set points, guest room plug and lighting loads, as well as the profiles of miscellaneous loads in the hotel. The building energy audit and ongoing communication between PNNL and building staff helped in gathering lists of energy-consuming equipment and circuits as well as understanding how the equipment was being used and operated.

Having actual metered data assisted the team in creating a more accurate simulation model than would have been possible based on assumptions or simulation program defaults. For example, while a typical building of Crowne Plaza's size would be expected to use a functional control system to reduce temperatures during off hours, the metered data showed that many zones were not set back, but instead operated 24 hours per day at a single setting.

Using the building energy model, the team was able to predict the effectiveness of each of the EEMs to determine its suitability for Crowne Plaza and to form a final package of recommended EEMs.

To assess whole-building savings, three different energy models were created. Model 1 was the pre-retrofit building baseline calibrated using the metered data. Model 2 represented the building modeled to the prescriptive specifications in an ASHRAE 90.1-2004 baseline. Model 3 represented the proposed design based on the energy measures currently planned for the project.

Model 1 - Pre-Retrofit Building

The first model represented the pre-retrofit building that was metered to calibrate the model and had an annual energy use intensity (EUI) of approximately 147 kBtu/ft^2.

Model 2 - Code Baseline

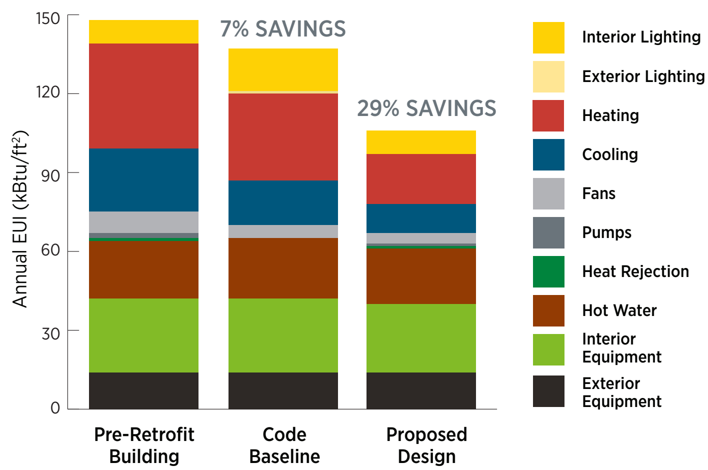
The second model represents the building modeled to the prescriptive specifications in an ASHRAE 90.1-2004 baseline. The code baseline building model had an annual EUI of 137 kBtu/ft^2.

Model 3 - Proposed Design

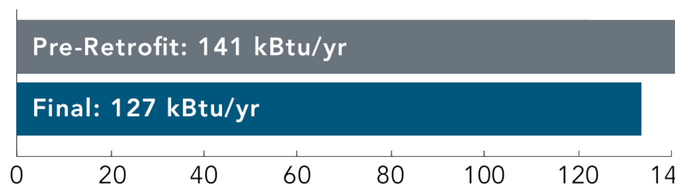
The third model included the EEMs incorporated into the design. This model had an annual EUI of about 104 kBtu/ft^2 and an annual energy savings of 29% over historic operations. Implemented measures to date have resulted in savings estimated at 14%.

By comparing the 2012 building energy use to the 2008 baseline, even though all measures have not yet been implemented, a total energy savings of over 10% or 2,100 million Btu per year were realized. The replacement of PTHPs in guest rooms using downsized and premium efficiency equipment and the use of the Ozone generator with the clothes washers contributed significantly to these savings. The EnergyPlus model showed that the PTHPs could be downsized, providing both capital cost and efficiency benefits. The smaller units were less expensive and, by downsizing, the new units operated more efficiently while better matching the load. Operation of the Ozone generator contributed to gas savings by reducing the hot water requirements of the clothes washers. Also, energy use was further reduced from shorter dryer run times when wash cycles used Ozone generation during the laundry process.

Comparing Estimated EUI of Pre-Retrofit Building, Code Baseline, and Proposed Design Models



Actual Whole-Building Energy Consumption Before and After Energy Updates[1]



[1] The data reflects normalization and both weather and occupancy corrections.

Estimated Annual Energy Use and Percentage Savings by End Use

End Use Category	Pre-Retrofit Building	Code Baseline	Proposed Design	
	Annual EUI (kBtu/ft^2)	Annual EUI (kBtu/ft^2)	Annual EUI (kBtu/ft^2)	Percent Savings over Pre-Retrofit Building
Interior Lighting	9	16	9	0
Exterior Lighting	0	1	0	0
Heating	40	33	19	52
Cooling	24	17	11	55
Fans	8	5	4	54
Pumps	2	0	1	59
Heat Rejection	1	0	1	14
Hot Water	22	23	21	8
Interior Equipment	28	28	26	8
Exterior Equipment	14	14	14	0
Total	147	137	104	29

Expected Building Energy Savings from Implemented EEMs by End Use versus Pre-Retrofit Building

Electricity End Use Category

Heating	884,000 kWh
Cooling	544,000 kWh
Fans	178,000 kWh
Pumps	54,000 kWh
Heat Rejection	5,800 kWh
Interior Equipment	48,000 kWh
Electricity Total	1,714,000 kWh

Natural Gas End Use Category

Hot Water	2,500 therms
Interior Equipment	1,500 therms
Natural Gas Total	4,000 therms

Lessons Learned

Value Regular Energy Use Assessments

One of the key lessons of this CBP project is the value of frequent energy use assessments. B.F. Saul Co. is now more cognizant of the effect that the operation and replacement of equipment has on the bottom line. The company also appreciates the value of an integrated design approach that provides a plan for improving the whole building. This enables the company to consider the long-term goals whenever a system change or upgrade is made. B.F. Saul Co. also recognizes that undergoing a building renovation affords greater opportunity for integrated and comprehensive efficiency improvements than a building retrofit.

Details Matter

Attention given to detail is important in metering and retrofit projects. Measuring energy at the end use level helps define the building's energy profile and guides the design of appropriate EEMs. As changes and upgrades are made, the building owner is able to understand the initial baseline usage and then objectively measure and see the impact of improvements.

Consider Nonenergy Benefits

The building receives more value from implementing the measures than just getting a more efficient piece of equipment and reducing costs. These changes provide significant nonenergy benefits that include a positive customer experience. During the packaged terminal heat pump (PTHP) replacement project, premium efficiency units were selected. As a result of installing the PTHPs, both operational costs and sound levels dropped, which provided both owner and guest satisfaction.

Information Sharing is Key

It is important to share energy savings information such as baseline metering efforts, lessons learned, and the implementation experience with other building owners and franchise holders. Energy efficiency strategies can be deployed by others in the hospitality industry with success. Energy use can be reduced, environmental comfort can be improved, and the customer will have a more positive experience.

Timing is Important

Many measures identified for the Crowne Plaza require equipment change outs or renovation of the building envelope. The schedule for implementing these changes will likely depend on the useful life of the existing equipment and the timing of building renovations that take place to accommodate more than energy efficiency improvements. Thanks to measures such as upgrading packaged terminal heat pumps (during a scheduled change out), adding a laundry ozone system, and replacing a chiller, the hotel has already achieved 10% improvement in operating efficiency.

References and Additional Information

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